

PATENT

Atty. Dkt. No. Viswanathan 16 (LCNT/124157)

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LISTING OF THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1 1. (Previously presented) A method for use in a system adapted to transmit at least
2 four series of transmit sequences over at least four transmit antennas, the method comprising the
3 step of:

4 space-time coding at least two pairs of symbol sub-streams, each of the pairs of symbol
5 streams being space-time coded to form a respective pair of the transmit-sequence chains, the
6 space-time coding being such that at least one of the formed pairs of the transmit-sequence
7 chains is a function of symbols of the respective pair of symbol sub-streams and not a function of
8 the symbols of the other pairs of the symbol sub-streams;

9 wherein each transmit sequence of a particular transmit-sequence chain is a function of 1)
10 a symbol of one of the symbol sub-streams of the respective symbol sub-stream pair and 2) a
11 complex conjugate of a symbol of the other symbol sub-stream of the respective symbol sub-
12 stream pair.

1 2. (Previously presented) The invention of claim 1, wherein:
2 each transmit sequence has a duration of four symbol periods; and
3 portions of the at least four transmit-sequence chains are representable by a matrix where:
4 each row of the matrix represents one transmit sequence of a respective different one of
5 the transmit-sequence chains; and
6 each column of the matrix represents one symbol period.

1 3. (Original) The invention of claim 2, wherein the matrix is orthogonal.

1 4. (Original) The invention of claim 1, wherein portions of the at least four transmit-
2 sequence chains are representable by a matrix where:

3 each row of the matrix represents one transmit sequence of a respective different one of
4 the transmit-sequence chains;

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5 each column of the matrix represents one symbol period; and

6 the matrix is
$$\begin{bmatrix} b_1 & b_1 & -b_2^* & -b_2^* \\ b_2 & b_2 & b_1^* & b_1^* \\ b_3 & -b_3 & -b_4^* & b_4^* \\ b_4 & -b_4 & b_3^* & -b_3^* \end{bmatrix},$$

7 where:

8 b_1 and b_2 are symbols of first and second symbol sub-streams, respectively, of one of the
9 symbol-sub-stream pairs,

10 b_3 and b_4 are symbols of first and second symbol sub-streams, respectively, of another of
11 the symbol-sub-stream pairs, and

12 b_1^* , b_2^* , b_3^* , and b_4^* are complex conjugates of b_1 , b_2 , b_3 , and b_4 , respectively.

1 5. (Original) The invention of claim 1, wherein portions of the at least four transmit-
2 sequence chains are representable by a matrix where:

3 each row of the matrix represents one transmit sequence of a respective different one of
4 the transmit-sequence chains;

5 each column of the matrix represents one symbol period; and

6 the matrix is
$$\begin{bmatrix} b_1 & -b_2^* & 0 & 0 \\ b_2 & b_1^* & 0 & 0 \\ 0 & 0 & b_3 & -b_4^* \\ 0 & 0 & b_4 & b_3^* \end{bmatrix},$$

7 where:

8 b_1 and b_2 are symbols of first and second symbol sub-streams, respectively, of one of the
9 symbol-sub-stream pairs,

10 b_3 and b_4 are symbols of first and second symbol sub-streams, respectively, of another of
11 the symbol-sub-stream pairs, and

12 b_1^* , b_2^* , b_3^* , and b_4^* are complex conjugates of b_1 , b_2 , b_3 , and b_4 , respectively.

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1 6. (Original) The invention of claim 1, wherein the space-time coding step
2 comprises the steps of:

3 space-time coding a first pair of symbol sub-streams to form a first pair of transmit-
4 sequence chains, the first pair of transmit-sequence chains being a function of the symbols of the
5 first symbol-sub-stream pair and not a function of the symbols of a second symbol-sub-stream
6 pair; and

7 space-time coding the second pair of symbol sub-streams to form a second of transmit-
8 sequence chains, the second pair of transmit-sequence chains being a function of the symbols of
9 the second symbol-sub-stream pair and not a function of the symbols of the first symbol-sub-
10 stream pair.

1 7. (Previously presented) The invention of claim 1, further comprising the step of:
2 transmitting the at least four transmit-sequence chains on a respective one of the transmit
3 antennas.

1 8. (Previously presented) The invention of claim 1, further comprising the step of:
2 spreading at least a plurality of symbols of the transmit-sequence chains using a
3 spreading code.

1 9. (Original) The invention of claim 1, further comprising the steps of:
2 channel coding each of at least four data sub-streams using a channel code; and
3 mapping each of the channel-coded primitive data stream into symbol-space to produce a
4 respective one of the symbol sub-streams.

1 10. (Previously presented) A transmitter adapted to transmit at least four symbol sub-
2 streams, the transmitter comprising:
3 a space-time encoder adapted to space-time code at least two pairs of symbol sub-
4 streams, each of the pairs of symbol streams being space-time coded to form a respective pair of
5 the transmit-sequence chains, the space-time coding being such that at least one of the formed

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6 pairs of the transmit-sequence chains is a function of symbols of the respective pair of symbol
 7 sub-streams and not a function of the symbols of the other pairs of the symbol sub-streams;
 8 wherein each transmit sequence of a particular transmit-sequence chain is a function of 1)
 9 a symbol of one of the symbol sub-streams of the respective symbol-sub-stream pair and 2) a
 10 complex conjugate of a symbol of the other symbol sub-stream of the respective symbol sub-
 11 stream pair; and
 12 at least four transmit antennas, each having an input for receiving at least one of the at
 13 least four transmit-sequence chains, the input coupled to an output of the space-time encoder.

1 11. (Previously presented) The invention of claim 10, wherein:
 2 each transmit sequence has a duration of four symbol periods; and
 3 portions of the at least four transmit-sequence chains are representable by a matrix where:
 4 each row of the matrix represents one transmit sequence of a respective different one of
 5 the transmit-sequence chains, and
 6 each column of the matrix represents one symbol period.

1 12. (Original) The invention of claim 11, wherein the matrix is orthogonal.

1 13. (Original) The invention of claim 10, wherein portions of the at least four
 2 transmit-sequence chains are representable by a matrix where:
 3 each row of the matrix represents one transmit sequence of a respective different one of
 4 the transmit-sequence chains;
 5 each column of the matrix represents one symbol period; and
 6 the matrix is one of the matrices of the set of matrices consisting of:

$$7 \quad \begin{bmatrix} b_1 & b_1 & -b_2^* & -b_2^* \\ b_2 & b_2 & b_1^* & b_1^* \\ b_3 & -b_3 & -b_4^* & b_4^* \\ b_4 & -b_4 & b_3^* & -b_3^* \end{bmatrix} \text{ and } \begin{bmatrix} b_1 & -b_2^* & 0 & 0 \\ b_2 & b_1^* & 0 & 0 \\ 0 & 0 & b_3 & -b_4^* \\ 0 & 0 & b_4 & b_3^* \end{bmatrix},$$

8 where:

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- 9 b_1 and b_2 are symbols of first and second symbol sub-streams, respectively, of one of the
10 symbol-sub-stream pairs,
11 b_3 and b_4 are symbols of first and second symbol sub-streams, respectively, of another of
12 the symbol-sub-stream pairs, and
13 b_1^* , b_2^* , b_3^* , and b_4^* are complex conjugates of b_1 , b_2 , b_3 , and b_4 , respectively.

1 14. (Original) The invention of claim 10, wherein the space-time encoder is adapted
2 to spread at least a plurality of symbols of the transmit-sequence chains using a spreading code.

1 15. (Previously presented) The invention of claim 10, wherein the transmitter further
2 comprises:

3 an input; and

4 at least one channel encoder being interposed between the input and the space-time
5 encoder, the channel encoder being adapted to channel code a data sub-stream using a channel
6 code.

1 16. (Original) The invention of claim 15, wherein the transmitter further comprises at
2 least one mapper, the mapper being interposed between the channel encoder and the space-time
3 encoder, the mapper being adapted to map the channel coded data sub-stream into symbol-space
4 to produce a respective one of the symbol sub-streams.

1 17. (Original) A base station of a wireless communication system, the base station
2 comprising the transmitter of claim 10.

1 18. (Original) A mobile terminal comprising the transmitter of claim 10.

1 19. (Original) The invention of claim 10, further comprising a plurality of radio
2 frequency units, each having an input coupled to a respective output of the space-time encoder,
3 each radio frequency unit adapted to convert a respective transmit sequence series from baseband
4 to a radio frequency modulated signal.

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1 20. (Withdrawn) A receiver comprising:
 2 at least one receive antenna; and
 3 a matrix multiplier for multiplying a matrix with received symbol sub-streams of a signal
 4 received by the receive antenna, the matrix having at least two pairs of consecutive rows, each
 5 such pair being a function of channel characteristics of at least two channels that terminate on the
 6 receive antenna but not of channel characteristics of other channels that terminate on the receive
 7 antenna, and the matrix being orthogonal;
 8 wherein the sequence of received symbols of a particular channel is a function of 1) a
 9 symbol of one of the symbol sub-streams associated with one of the channels of the respective
 10 channel pair and 2) a complex conjugate of a symbol of the other symbol sub-stream associated
 11 with the other channel of the respective channel pair.

1 21. (Withdrawn) The invention of claim 20, wherein the matrix is H^T , which
 2 comprises one of the matrices of the set of matrices consisting of:

$$3 \quad \begin{bmatrix} h_1^* & h_1^* & h_2 & h_2 \\ h_2^* & h_2^* & -h_1 & -h_1 \\ h_3^* & -h_3^* & h_4 & -h_4 \\ h_4^* & -h_4^* & -h_3 & h_3 \end{bmatrix} \text{ and } \begin{bmatrix} h_1^* & h_2 & 0 & 0 \\ -h_2^* & h_1 & 0 & 0 \\ 0 & 0 & h_3^* & h_4 \\ 0 & 0 & -h_4^* & h_3 \end{bmatrix},$$

4 where h_1 , h_2 , h_3 , and h_4 are the complex channel characteristics of the channels between
 5 a 1st, 2nd, 3rd, and 4th channel encoder, respectively and the receive antenna.

1 22. (Withdrawn) The invention of claim 21, wherein the channels are flat-faded
 2 channels.